ABSTRACT:

In this field trial, a new monitoring technique using distributed strain sensing known as Brillouin Optical Time Domain Reflectometry (BOTDR) was introduced to monitor the behavior of bolted-concrete linings of a recently completed tunnel when a second bored tunnel was constructed side by side at a distance less than one tunnel diameter apart. This was done by measuring circumferential strains in 12 rings using optical fiber that was installed using the point-fixing method. The strain distributions around the circumference of the rings show a generally similar profile. Maximum compressive strains measured below the tunnel springline nearest to the excavated tunnel were larger than the maximum tensile strains measured at the tunnel crown, distorting the circular tunnel into an oval/ellipsoid that was about symmetrical to the horizontal axis. Several methods were introduced in order to compare strain measurements made by BOTDR and diameter changes recorded by tape extensometer. This involves the use of a symmetrical tunnel distortion model and the basic differential equation for a circular arch. The calculated results showed some degree of similarity between the two methods. The analysis highlighted the importance of measuring the axial strain in the tunnel ring and subtracting the axial strain component in order to calculate the actual deflection of the lining due to bending.